RESEARCH DEPARTMENT

INTERIM REPORT ON CRYSTAL PALACE BAND IV SURVEY

Report No. K-127

(1957/15)

THE BRITISH BROADCASTING CORPORATION
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SUMMARY

This report describes the results of a field strength survey of the Band IV horizontally polarised transmissions from the Crystal Palace low-power transmitter working on a frequency of 495 Mc/s. The service area of a transmitter with an effective radiated power (e.r.p.) of 1 megawatt has been calculated from the survey measurements.

A comparison was made between radiation on horizontal and vertical polarisation in Band IV. The results obtained were similar to those in Band III, namely that the value of the median field strength was substantially the same but with a greater degree of scatter on horizontal polarisation.

Observation of multipath interference shows that the number of echoes visible is much greater than in Band I. At most of the sites selected for investigation echoes were visible, but the use of a directional aerial substantially reduced the interference. Since a Band IV directional aerial is of compact proportions, this problem may be more easily solved than on Band I, but further investigation is required on this important point.

1. INTRODUCTION

The report has been compiled from the results of a field strength survey of a Band IV transmitter sited at Crystal Palace.

Measurements have been made in some detail, as this was the first survey made in this band by the B.B.C. Research Department. The investigation has extended to measurement of both horizontally and vertically polarised transmissions, and to simultaneous Band I/IV measurements for comparison purposes. Observations have also been made of the multipath interference experienced in a limited area.

The survey involved the use of a new method of chart analysis, and some further study of the results is necessary. The conclusions, together with the full details of the Band I/IV comparison will appear in the final report on the survey.

2. GENERAL

The transmitter used for this survey was installed at the Band I television transmitter site at Crystal Palace, the aerial being mounted on the self-supporting mast at a height of 430 ft (131 m) above ground level. The transmissions were made on 495 Mc/s, the carrier was square-wave modulated at 1 kc/s and radiated from a directional horizontally polarised aerial with a mean effective radiated power of

700 W in the direction of maximum radiation. The e.r.p. was 6 dB below this figure at ± 30° from the maximum so that it was necessary to make the survey in sectors of 60°, with appropriate correction to allow for the variation of e.r.p. over this arc.

A v.h.f./u.h.f. fixed frequency receiver was used for the survey in conjunction with a batwing (superturnstile) omnidirectional aerial. The mid-point of this aerial was 12 ft (3·65 m) above ground level, and continuous record charts of field strength were made on a recording milliammeter using the technique normally employed for v.h.f. surveys.

All field strength values quoted in this report, except where otherwise stated, have been corrected for an e.r.p. of 1 megawatt and for a receiving aerial height of 30 ft (9·2 m) above ground level. In previous surveys at lower frequencies a proportional height-gain correction has been added to the value measured in order to quote field strength at 30 ft (9·2 m). It can be shown that at u.h.f. the receiving aerial height-gain factor will be more dependent upon distance from the transmitter and the nature of the terrain than at v.h.f. and direct proportionality may apply in only a few cases. Measurements have in fact shown that the average value of the height gain over the whole of the area within optical range is rather lower than the 30 ft/12 ft (9·2 m/3·65 m) proportional value and in some cases the deviation from the mean is large.

In regions where diffraction affects the field strength the height-gain value is more difficult to predict and, since loss due to diffraction over a straight edge is approximately proportional to $\sqrt{f}$ for large diffraction angles, it is to be expected that local obstructions will cause greater loss at the higher frequencies. This effect would account for the greater differences between the field strength at normal measuring height and those at roof-top level observed in built-up areas and the effect is no doubt accentuated by the greater opacity of obstructions, such as buildings, at these higher frequencies.

After due consideration had been given to the results obtained in preliminary tests, it was decided that the most expedient method of measurement for the survey would be to use values estimated to be those which would be obtained in the absence of local obstructions at 12 ft (3·65 m), and then correct with an average open country height gain which, for this survey, was found to be 5 dB. When the continuous survey was being made in built-up areas only those parts of the chart were considered where there was a clear field of view towards the transmitter unobstructed by local buildings, etc. The values given are thus those which may be expected clear of the shadow of local obstructions.

The details concerning this method of analysis and the work involved in its derivation will be found in a report to be issued later.

3. RESULTS

3.1. Field Strength Contour Map

Fig. 1 (map T.381) shows the coverage over the Home Counties down to a median field strength of 1 mV/m, which is the lowest equivalent field strength for an

T381

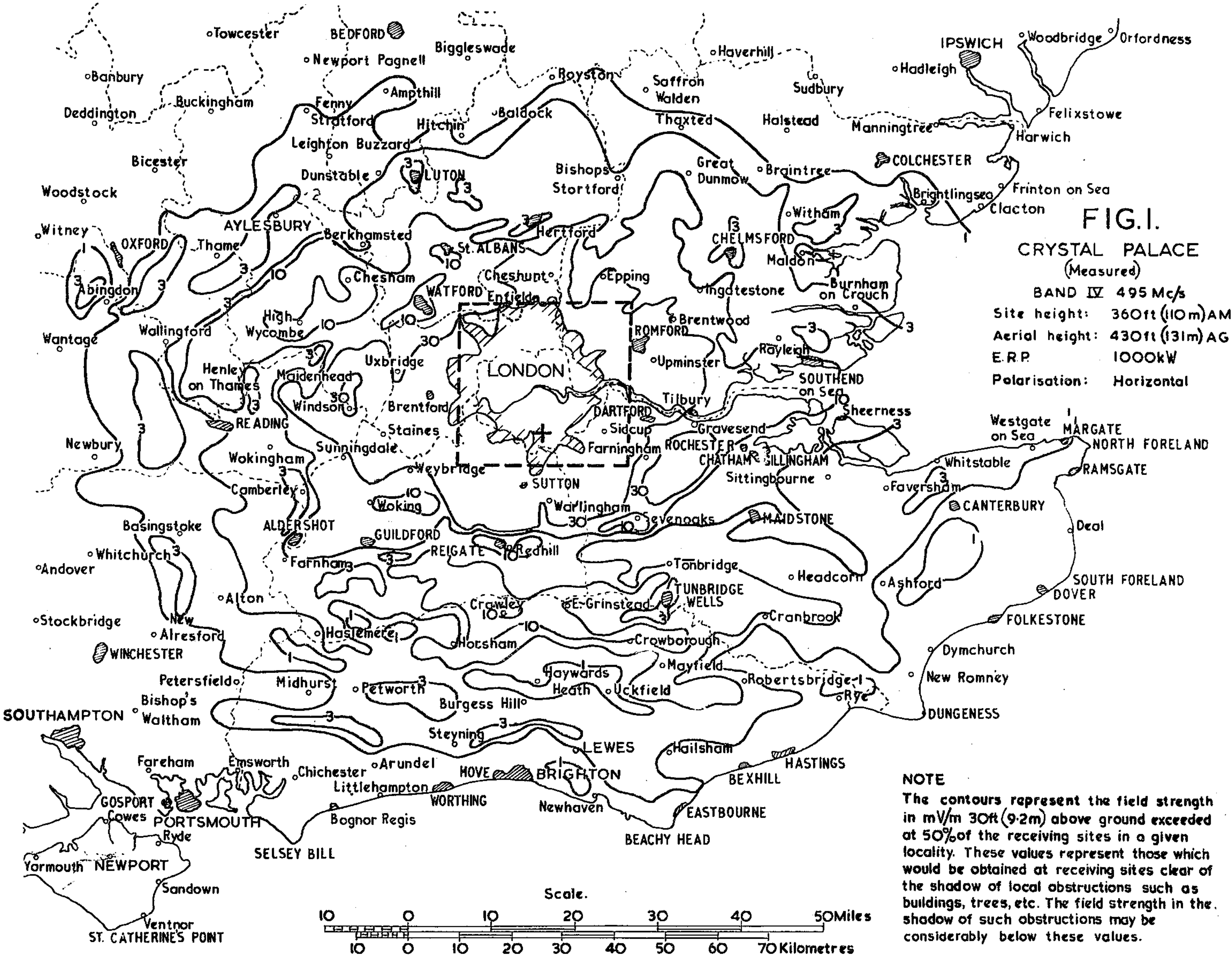

FIG. I.

CRYSTAL PALACE

(Measured)

BAND IV 495 Mc/s

Site height: 360 ft (110 m) AMSL

Aerial height: 430 ft (131 m) AGL

E.R.P. 1000 kW

Polarisation: Horizontal

NOTE

The contours represent the field strength in mV/m 30ft (9·2m) above ground exceeded at 50% of the receiving sites in a given locality. These values represent those which would be obtained at receiving sites clear of the shadow of local obstructions such as buildings, trees, etc. The field strength in the shadow of such obstructions may be considerably below these values.

e.r.p. of 1 MW that could accurately be measured from the low-power test transmitter. A further map of the London area is in preparation and will be presented with the final report. The service area map is based primarily on measurements in towns and villages and represents the median value of field strength available in such populated areas. The field strength in open country is likely to be in excess of the town values, although further investigation is necessary to confirm that the method of analysis used does not give a slightly optimistic figure in built-up areas in fringe regions. Table 1 shows the median field strengths in towns which were measured during the survey. Because of the very large variation of field strength over a short distance, due to screening and terrain effects, the particular value at any location in a town may differ from the median value by a large amount. In order to indicate the range of variation it is intended to publish maximum, minimum and median values in the final report, but further work is necessary on the method of analysis before the maximum and minimum figures can be given with accuracy.

It is emphasised that the values shown in this table are based upon measurements clear of local obstructions. Where a value is not shown the field strength was less than 1 mV/m and below accurate measuring level. Such a low value would not in any case be expected to provide a useful service.

TABLE 1

Field Strength (mV/m) at 30 ft (9·2 m) AGL

E.R.P. = 1 megawatt
Horizontal Polarisation

Town	Median
Aldershot	16
Alton	1·4
Amersham	8·0
Ascot	28
Ashford (Kent)	–
Aylesbury	2·2
Basingstoke	1·8
Beaconsfield	18
Berkhamsted	1·6
Bexhill	–
Billericay	20
Billingshurst	1·8
Bishops Stortford	3·2
Bognor	–
Bracknell	6·3
Braintree	2·5
Brentwood	25
Brighton	–
Burgess Hill	1·0
Burnham-on-Crouch	4·0

Town	Median
Camberley	1·6
Canterbury	–
Canvey	12·5
Caterham	50
Charing	2·8
Chatham (North)	1·8
(South)	7·0
Chelmsford (North)	3·2
(East)	5·6
(South)	1·8
Chertsey	100
Chipping Ongar	20
Coulsdon	180
Crawley	8·9
Crowborough	11
Cuckfield	1·2
Dartford (North)	110
(Centre)	35
(South)	63
Dorking	8·0
Dunstable	1·6
Eastbourne	–
East Grinstead	5·6
Edenbridge	4·0
Epping	90
Epsom	63
Eridge	2·5
Erith	18
Esher	50
Farnborough (Hampshire)	3·2
Farnborough (Kent)	100
Farnham	6·3
Faversham	1·0
Fleet	3·2
Gerrards Cross	40
Gillingham (North)	3·5
(South)	5·6
Godalming	2·0
Godstone	8·0
Gravesend (Centre)	16
(South)	16
Grays Thurrock	45
Greenhithe	32
Guildford (North)	16
(East)	10
(South)	5·0
(West)	45

Town	Median
Harlow	3·2
Harpenden	4·0
Hartfield	4·5
Haslemere	1·0
Hastings	–
Hatfield	3·2
Hatfield New Town	4·5
Hayes (Middlesex) (North)	90
(South)	80
Haywards Heath	1·3
Hemel Hempstead	3·2
Herne Bay	2·2
Hertford	1·8
High Wycombe	6·3
Hitchin	–
Horley	6·3
Hornchurch	90
Horsham (North)	2·5
(South)	2·0
Hounslow	80
Laindon	16
Leatherhead	18
Leigh-on-Sea	20
Leighton Buzzard	1·8
Letchworth	–
Lewes	–
Lingfield	10
Littlehampton	–
Luton (North)	1·4
(East)	3·5
(South)	2·5
(West)	2·5
(Centre)	1·8
Maidenhead	25
Maidstone (North)	2·8
(South)	5·6
(West)	–
(Centre)	1·0
Maldon	–
Margate	1·3
Mayfield	3·2
Newbury	–
Newhaven	–
Northwood	18
Oxford	–
Oxted	11

Town	Median
Pembury	3·2
Petersfield	–
Petworth	2·2
Pulborough	1·3
Ramsgate	–
Rayleigh	8·0
Reading (North)	3·5
(East)	4·0
(South)	2·8
(West)	1·8
(Centre)	1·4
Redhill	9·0
Reigate	10
Rickmansworth	8·0
Rochester (North)	1·3
(South)	5·0
Rochford	1·6
Romford (North)	50
(East)	45
(South)	110
(Centre)	90
Ruislip	50
St, Albans (North and East)	10
(Centre)	4·0
Sevenoaks	7·1
Sheerness (East)	3·2
(West)	5·6
Shoeburyness	4·0
Sittingbourne	1·1
Slough (North)	28
(South)	25
Southall	90
Southend (North)	2·2
(South)	17
(West)	5·6
(Centre)	5·0
Stevenage	3·2
Stevenage New Town	5·6
Staines	70
Tenterden	1·1
Three Bridges	7·1
Tonbridge (North)	1·3
(South)	5·0
(Centre)	–
Tunbridge Wells (North)	4·0
(South)	–
(Centre)	–

Town	Median
Uckfield	–
Upminster	110
Uxbridge	22
Wadhurst	1·8
Waltham Abbey	20
Walton-upon-Thames	63
Ware	5·0
Watford (North)	7·1
(South)	6·3
Welwyn Garden City	4·0
Wendover	2·5
Westerham	9·0
Weybridge	11
Whitstable	2·2
Wickford	2·8
Winchester	–
Windsor	16
Witham	2·0
Woking	10
Wokingham	4·0

The whole of the field strength survey was made with horizontally polarised transmission, but one sector (350° ± 30°) was repeated with vertical polarisation. The same routes were followed in the continuous survey, and multipath interference measurements were repeated at all previous sites used for horizontal polarisation measurements. Table 2 lists some of the towns surveyed with the field strength values obtained on both horizontal and vertical polarisation. A full list of the towns surveyed using vertical polarisation will be included in the final report.

TABLE 2

Field Strength (mV/m) at 30 ft (9·2 m) AGL
E.R.P. = 1 megawatt

Town	Vertical Polarisation Median	Horizontal Polarisation Median
Cheshunt	35	32
Elstree	12·5	11
Hoddesdon	36	40
Hemel Hempstead	3·5	3·2
King's Langley	11·2	12·5
Leighton Buzzard	2·2	1·8
Luton (North)	1·8	1·4
(South)	2·5	2·5
(East)	5·0	3·5
(West)	2·5	2·5
(Centre)	1·6	1·8
Radlett	12·5	11
Stevenage	2·8	3·2
Stevenage New Town	5·6	5·6

From this table it will be seen that there is good correlation between the median values on both polarisations. As previously stated, further work is necessary before maximum and minimum values can be given, but from a preliminary investigation it appears that the range from maximum to minimum is generally greater on horizontal polarisation. The result of a fuller investigation into local variation factor on both vertical and horizontal polarisation will appear in the final report.

3.2. Multipath Interference

Observations were made in the 350° sector to determine the degree of multipath interference to be expected on Band IV. At lower frequencies using the 405-line system discrete echoes become most apparent when their delay time is greater than about 2 microseconds and when their amplitude approaches to within 20 dB of the direct signal. Since higher definition may be contemplated for Band IV, these limits may no longer apply, and the short-range echo of less than 2 microseconds delay may assume serious proportions.

As with other frequencies previously investigated, multipath becomes most pronounced when the receiving aerial is screened from the transmitter, particularly where there is an open view behind the receiving site. Such situations were investigated in Hampstead, where a hill screened the transmitter. Observations made on the north face of this hill disclosed many echoes up to 40 microseconds delay, but the amplitude of the long-range ghosts was generally of a low order. However, the short-range echoes present greater difficulty, as their amplitudes are usually much higher and, since many objects in a built-up area assume wavelength proportions at Band IV frequencies, many short-range echoes are apparent. Also, although good field strength values have frequently been synonymous with little multipath interference, short-range echoes of considerable amplitude have been observed at sites where the field strength was very good. Thus it may often be necessary to use a directional aerial even in areas of very good field strength. This is particularly true in Central London, where echoes at short range from surrounding buildings were very prominent.

Seventy sites were picked at random, and the investigation was made using a dipole aerial and a six-element Yagi. It was found that in the great majority of sites where discrete echoes were visible, the directional aerial reduced their amplitudes to negligible proportions. Fluctuation of direct signal and of echoes due to passing traffic was intense at times, and at one site a periodic echo was eventually traced to a rotating clock sited on the roof of an instrument manufacturers in North London. The peak of this echo was within 3 dB of the direct signal.

The investigation was made on both horizontal and vertical polarisation and the results are given in Fig. 2. The sites have been separated into those in built-up and open areas, and it will be seen that in built-up areas fewer echoes are observed on horizontal polarisation. It was observed when the survey was in progress that many more low-amplitude echoes (i.e. amplitude less than -30 dB) were visible on vertical polarisation in towns.

Although the limits at which multipath interference becomes troublesome have not yet been determined, it seems clear that horizontal polarisation offers a somewhat better service in built-up areas. In addition, a horizontally polarised directional receiving aerial offers a more selective radiation pattern than a similar aerial on vertical polarisation. However, since the short-range echoes may be very troublesome in a high definition service, it is necessary to consider the time delay as well as the amplitude of the echoes. It is intended to discuss this aspect in the final report.

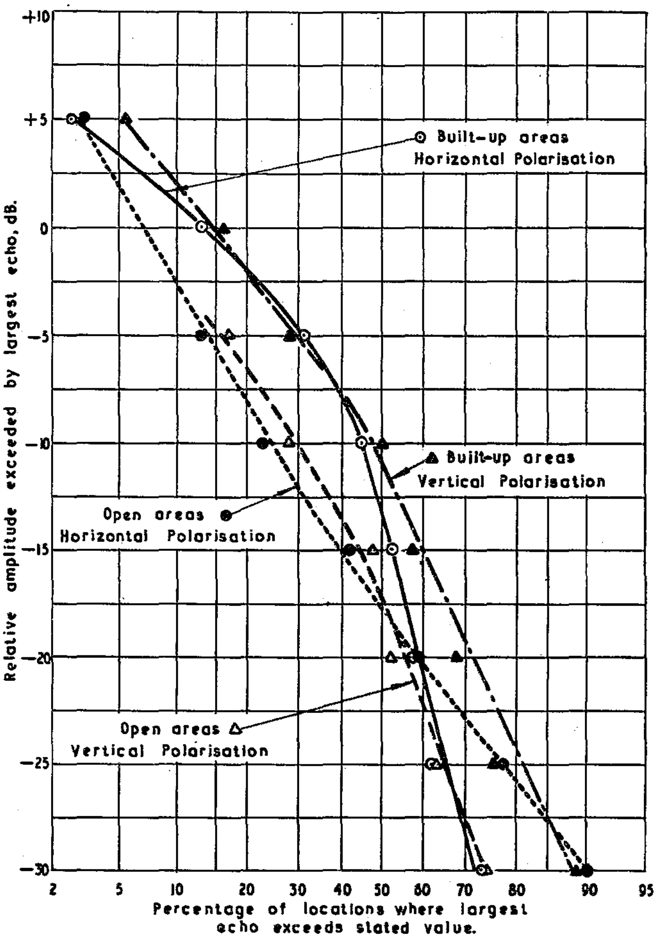

Fig. 2

4. CONCLUSION

The preliminary investigation outlined in this report shows that a Band IV transmitter of high effective radiated power sited at Crystal Palace would provide a useful service to a significant proportion of the population of south-east England and in the Greater London areas in particular.

Multipath interference must be expected to be much worse on Band IV than on Band I, and care would have to be taken in the erection of directional aerials, though their smaller physical size will facilitate the provision of aerials suitable for the elimination of such interference. If a service of high definition is contemplated, the existence of very short-range echoes of high relative amplitude will be important. It is not yet possible to forecast the extent to which the use of directional aerials may suffice to reduce their effect.

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